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JC13 Rec'd PCT/PTO 05 FEB 2001Attny Docket No. W1100/20054
PTO CUSTOMER NO. 03000**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

International Application No. : PCT/GB99/02328

International Filing Date : August 4, 1999

Priority Application
and Date Claimed : US 60/095,563
Filed August 6, 1998

Title of Invention : METHOD AND APPARATUS FOR MONITORING
WATER BALANCE IN A PAPER MACHINE

Applicant(s) for DO/EO/US : David Andrew LILBURN

Box PCT (EO/US)
Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).
3. A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

10/009540
JC13 Rec'd PGT/PTO 05 FEB 2001

4. A copy of the International Application as filed (35 U.S.C 371(c)(2)) has been transmitted by the International Bureau. A copy of the cover sheet of international application as published under International Publication No. WO 00/08462 is enclosed.
5. A Preliminary Amendment is enclosed, including seven pages of new claims and Abstract (sheets 12-19).
6. A Declaration will follow.
7. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(1)(1)-(5):

Claims Fee	For	Number Filed	Number Extra	Rate	Calculation
	Total Claims	21	1	x 18	\$ 18
	Independent Claims	2	0	x 80	
	Multiple Dependent Claims			x260	
Basic Fee	U.S. PTO was not International Preliminary Examination Authority. Search report on the international application was prepared by the European Patent Office				\$ 860
	Total of above Calculations				\$ 878
	Reduction by 1/2 for filing by small entity				\$ 0
	TOTAL NATIONAL FEE				\$ 878

Please charge counsel's account no. 03-0075 in the amount of \$878, or any additional amount which may be required, to cover the above fees. A duplicate copy of the calculation sheet is enclosed.

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JC13 Rec'd PCT/PTO 05 FEB 2001**AUTHORIZATION TO CHARGE ADDITIONAL FEES**

The Commissioner is hereby authorized to charge the following additional fees which may be required by this paper and during the entire pendency of this application to counsel's deposit account no. 03-0075:

1. 37 CFR 1.492(a)(1), (2), (3) and (4) (filing fees)
2. 37 CFR 1.492(b), (c) and (d) (presentation of extra claims)
3. 37 CFR 1.17 (application processing fees)
4. 37 CFR 1.492(e) and (f) (surcharge fee for filing declaration and/or filing an English translation of an International Application later than 30 months after the priority date)

This application and items attached are being transmitted before the 30 month claimed priority date.

Respectfully submitted,

CAESAR, RIVISE, BERNSTEIN,
COHEN & POKOTILOW, LTD.

By


Michael J. Berkowitz

Reg. No. 39,607

12th Floor, Seven Penn Center

1635 Market Street

Philadelphia, PA 19103-2212

Attorneys for Applicant

10/009540

JC13 Rec'd PCT/PTO 05 FEB 2001

PATENT
Attny Docket No. W1100/20054
PTO Customer No. 03000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT EXAMINING OPERATION

Applicants : David Andrew LILBURN
Filed : February 5, 2001
Invention : METHOD AND APPARATUS FOR MONITORING
WATER BALANCE IN A PAPER MACHINE
U.S. national stage application
based on PCT/GB99/02328,
filed August 4, 1999
Priority : U.S. Application No. 60/095,563
filed August 6, 1998

PRELIMINARY AMENDMENT

Box PCT
Commissioner for Patents
Washington, D.C. 20231

Attention: DO/EO/US

Sir:

IN THE CLAIMS:

Cancel Claims 1-19, without prejudice, and add new Claims 20-40.

REMARKS

Please replace pages 12-17 of the claims in copending international Application No. PCT/GB99/02328 with new pages 12-18 attached hereto. Claims 20 through 40 remain in this application.

Claims 1-19 have been replaced by Claims 20-40 to eliminate multiple dependency included in the originally filed claims to conform the claims with U.S. practice.

10/009540

JC13 Rec'd PCT/PTO 05 FEB 2001

February 5, 2001
Applicant: David Andrew Lilburn
U.S. national stage application of PCT/GB99/02328
Page - 2 -

Old claim 3 (now claim 22) was amended to include the claim upon which it was dependent. Claims 5, 6 and 13-19 (now claims 24, 26 and 34-40) were amended and claims 25 and 27 were added, to eliminate multiple-dependency in the claims.

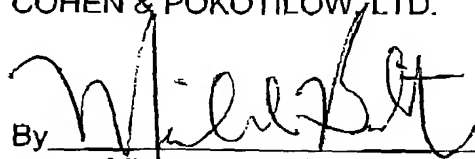
The Abstract of the Disclosure is also attached hereto to comply with the requirements of 37 C.F.R. §1.72(b).

Respectfully submitted,

CAESAR, RIVISE, BERNSTEIN,
COHEN & POKOTILOW, LTD.

February 5, 2001

By



Michael J. Berkowitz
Reg. No. 39,607
12th Floor, Seven Penn Center
1635 Market Street
Philadelphia, PA 19103-2212
Attorneys for Applicant

10/009540

JC13 Rec'd PCT/PTO 05 FEB 2001

12

CLAIMS

20. A method of monitoring the water balance in a paper machine comprising measuring the electrical conductivity of the water entrained in one or more press felts on entry to a press means, separately measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and comparing the measured electrical conductivities to determine the material balance.

21. A method according to claim 20 wherein the electrical conductivities are each measured by measuring the concentration of the same specific ions at entry to and on leaving the press means, and the linear relationship between the concentration if said ions are used to determine the electrical conductivity.

22. A method according to claim 20 wherein the material balance is calculated using the following formula:

$$\text{Flow (gpm)} \times \text{Conductivity IN} = \text{Flow (gpm)} \times \text{Conductivity OUT}$$

23. A method according to claim 22 wherein the IN side of the equation is calculated using the following data:

- 1) Weight of Wet Web, as $\text{gpm} = f(\text{Tons/day \% water})$
- 2) Wet Web conductivity measured or calculated from previous press nip

- 3) Showers, as gpm, = f(nozzle size, pressure)
- 4) Showers conductivity - measured and weight averaged,
where f = flow rate, in gpm, as water.

24. A method according to claim 22 wherein the OUT side of the
equation is calculated using the following data:

- 1) Vacuum dewatering flow and conductivity, as measured;
- 2) Press water flow and conductivity, as measured;
- 3) Wet Web gpm, as Wet Web in minus vacuum dewatering
out, minus press water flow.

25. A method according to claim 23 wherein the OUT side of the
equation is calculated using the following data:

- 1) Vacuum dewatering flow and conductivity, as measured;
- 2) Press water flow and conductivity, as measured;
- 3) Wet Web gpm, as Wet Web in minus vacuum dewatering
out, minus press water flow.

26. A method according to claim 24 wherein wet web conductivity at
the outlet is calculated by solving the equation:

$$\text{WWI gpm} \times \text{WWI cond} + \text{Shower gpm} \times \text{Shower cond} =$$

$$\text{Uhle gpm} \times \text{Uhle cond} + \text{Press gpm} \times \text{Press cond} + (\text{WWI gpm} -$$

$$\text{Uhle gpm} - \text{Press gpm}) \times \text{WWO cond},$$

$$\text{wherein WWO cond} = \frac{A + B - C - D}{E}, \text{ wherein}$$

14

 $A = \text{WWI gpm} \times \text{WWI cond}$ $B = \text{Shower gpm} \times \text{Shower cond}$ $C = \text{Uhle gpm} \times \text{Uhle cond}$ $D = \text{Press gpm} \times \text{Press cond}$

5

 $E = \text{WWI gpm} - \text{Uhle gpm} - \text{Press gpm}$

27. A method according to claim 25 wherein wet web conductivity at the outlet is calculated by solving the equation:

$$\text{WWI gpm} \times \text{WWI cond} + \text{Shower gpm} \times \text{Shower cond} =$$
$$\text{Uhle gpm} \times \text{Uhle cond} + \text{Press gpm} \times \text{Press cond} + (\text{WWI gpm} -$$

10

 $\rightarrow \text{Uhle gpm} - \text{Press gpm}) \times \text{WWO cond},$
$$\text{wherein WWO cond} = \frac{A + B - C - D}{E}, \text{ wherein}$$
$$E$$
 $A = \text{WWI gpm} \times \text{WWI cond}$ $B = \text{Shower gpm} \times \text{Shower cond}$

15

 $C = \text{Uhle gpm} \times \text{Uhle cond}$ $D = \text{Press gpm} \times \text{Press cond}$ $E = \text{WWI gpm} - \text{Uhle gpm} - \text{Press gpm}$

28. A method according to claim 20 wherein the solids balance is determined from the following data:

20

In

$$\text{Wet Web in} = \text{WWI gpm} \times \text{conductivity}$$

15

Shower in = Shower gpm x conductivity, as measured

Out

Wet Web Out = WWO gpm x conductivity, as calculated;

Vacuum dewatering = gpm x conductivity, as measured;

5

Press Out = gpm x conductivity (as measured);

Shower water flow = gpm leaving press nip (X_p) + gpm leaving
vacuum dewatering (X_u), wherein

X_u = Shower gpm - X_p , and

10

Net Web flow out = gpm leaving press nip (Y_p) + gpm leaving
vacuum dewatering (Y_u), and

Y_u = Net Web outflow - Y_p .

29. A method according to claim 28 wherein the Uhle box balance is
determined from the following data:

Solids out = Flow x Conductivity

15

Flow = X_u

Conductivity = C_u

Solids In = Solids from shower water + solids from wet web

Solids from shower water = Shower concentration (C_s) x Shower
water leaving at Uhle box (S_u)

20

Solids from wet web = Wet web conductivity (WW_c) x Wet web
water (WW_u) leaving at Uhle box

so that $C_u \times X_u = WW_c \times WW_u + C_s \times S_u$.

30. A method according to claim 29 wherein Su = the flow rate of shower water in gallons per minute of shower water removed by the Uhle box flow, the amount of shower water removed at the press is determined as Total shower flow minus Su, and the amount of Wet Web water removed at the press is calculated by:

$$\text{Press Cond} \times \text{Press flow} = \text{Wet Web cond} \times \text{Wet Web flow at press,} + \text{Shower cond} \times \text{Shower flow at press,}$$
$$\text{i.e. } \mathbf{C}_p \times \mathbf{X}_p = \mathbf{W}\mathbf{W}^c \times \mathbf{W}\mathbf{W}^p + \mathbf{S}^c \times \mathbf{S}^p,$$

wherein Press flow (Xp) = Wet Web flow (WWp) + Shower flow (Sp),

so that

$$C_p \times (WW_p + S_p) = WW_c \times WW_p + S_c \times S_p, \text{ and}$$
$$WWp = \frac{Sc \times Sp - Cp \times Sp}{Cp - Wwc}$$

and the total flow at the press is determined by $X_p = WW_p + S_p$.

31. A method according to claim 30 wherein the overall flow in and out of each nip is calculated and the measured versus calculated flows compared to allow calculation of a flow error which is then applied to the outgoing sheet to determine sheet consistency.

- 5 32. Apparatus for monitoring the water balance in a papermachine comprising first measuring means for measuring the electrical conductivity of water entering a press means entrained in one or more press felts, second measuring means for measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and means for comparing the measured electrical conductivity to determine the material balance.
- 10 33. Apparatus according to claim 32 further comprising apparatus for measuring and reporting flow rates of water applied to the felt before the press means, and of water collected from the felt and paper web in the press means.
- 15 34. Apparatus according to claim 32 including calculator means adapted to receive said measurements of electrical conductivity and flow rate and to calculate the material balance.
35. Apparatus according to claim 32 wherein the press means comprise the entire press section of a papermachine, said section comprising a plurality of serially arranged roller nips.
36. Apparatus according to claim 32 wherein the press means comprise a single roller nip.
- 20 37. Apparatus according to claim 32 wherein the means for measuring the electrical conductivity of the water each comprise an electrohydrodynamic induction flow meter.

38. Apparatus according to claim 37 wherein a first such measuring means is located adjacent to an upper press felt immediately before its entry to a press section of a paper machine.
39. Apparatus according to claim 38 wherein a second such sensing means is located adjacent to a lower press felt immediately before its entry to said press section.
40. Apparatus according to claim 39 wherein a further such sensing means is located adjacent a paper web immediately after its emergence from said press section.

ABSTRACT

A press section of a papermachine has upper and lower press felts. Electrical conductivity sensors measure the electrical conductivity of the felts before entry to a press section. A further electrical conductivity sensor senses the electrical conductivity of a papers web as it emerges from the press section. Measurements are also taken of the flow of cleaning showers applied to the felts, and of water removed by the dewatering devices in the press section, and appropriate signals corresponding to these values are applied to a processor, which determines a material balance in accordance with a procedure set out in the description.

-1-

METHOD AND APPARATUS FOR MONITORING**WATER BALANCE IN A PAPER MACHINE**

This invention relates to a method and apparatus for monitoring the water balance in a paper machine, in particular in the press section of a paper machine.

In the press section of a paper machine, the wet fibre web is pressed between cylindrical rolls. Press fabrics are passed through the press nips with the web to cushion the web and to absorb water squeezed from the web. A series of press nips acts upon the web before it leaves the press section to pass to the dryer section of the paper machine.

The water removed from the paper web is partly absorbed by the press fabrics (usually one is provided on each face of the paper web), and the remainder is expelled mechanically from the last nip of the press section to be caught in a collection trough. After leaving the press section the press fabric is treated with additional water by showers to clean, condition and lubricate the fabric. The press fabric is then passed over a vacuum area, or one or more slots, such as Uhle boxes, which causes water to migrate to the surface of the fabric where it is removed by mechanical means.

The press section is intended to remove the maximum amount of water without compromising the quality of the paper web produced. The

-2-

amount of water removed is dependent on the nip pressure, the water absorbtion capacity of the press fabric, and the ability of the press rolls to carry water away from the press nip to the collection trough.

The water absorbtion capacity of the press fabric depends upon the water volume received from the cleaning sprays, the water removal capacity of the vacuum dewatering device, the cleanliness of the press fabric and the design characteristics of the press fabric.

At present it is not possible to know dryness of the paper web as it leaves each press nip or as it finally enters the dryer section. To measure the water content directly requires that the sheet be broken, and the machine be out of use for a costly period of downtime. Indirect measurement of the water content of the web requires that a material balance be determined by measuring water flow from the collection troughs, vacuum dewatering devices, and the water content remaining in the press fabric. The latter is measured using a microwave based moisture meter which is manually pressed into the fabric and moved across the width of the machine. In addition the water content entering press section must be measured or assumed.

Because the carrying out of these material balance procedures require expertise and time, they are not normally carried out except under special circumstances. Consequently, during the normal running of the

-3-

papermachine there are many unknowns which prevent optimisation of the water removal process.

The unknowns include the effect of press loading on distribution of water flow into the fabric and into the collection trough and overall removal; the effect of the fabric shower flow on the distribution of water flow and overall water removed; the effect of upstream conditions on water removed in the press section; the effect of the paper basis weight on water removal in the press section; the effect of fabric cleanliness on water flow and overall removal; the effect of vacuum levels, dwell time and airflow on water flow and overall removal; the effect of needle jet shower pressures on water flow and overall removal; the effect of roll cover hardness on water flow and overall removal; and the effect of press fabric design on water flow and overall removal.

US Patent 3,655,980 proposes measuring the drainage rate from slurry along the length of a forming wire, using a radiation source and radiation detectors. In US 3,724,957, the concentration of an optically active substance is measured using photoelectric detectors to determine the concentration of pulp and clay in a papermaking slurry, while US 3,860,168 uses a nucleonic detector to monitor the weight of paper sheet. Moisture sensors are used in US 5,093,795, 5,262,955 and 5,286,348. The first two measure the moisture content profile and adjust the moisture content

-4-

by adding water or steam to the web, and in the other an infra red sensor is used on the web emerging from the last dryer in a papermaking machine.

In US 4,752,356 the slurry is sampled at the wet end of a papermachine to determine the total organic carbon present as a measure of the requirement for cationic additive materials to neutralise anionic contaminants in the papermaking process, and in US 5,330,621 cellulose pulp slurry is continuously analysed to determine elemental constituents, by gamma neutron activation analysis or carbon content analysis. The measurements are not made on the papermachine during a papermaking process.

None of the measurement methods meet the requirements for continuous material balance monitoring during papermachine operation.

It is accordingly an object of this invention to provide a method and apparatus for monitoring the water balance in a papermachine which enables the monitoring to be carried out whilst the machine is operating, and preferably on a continuous or frequent basis.

According to the invention, a method of monitoring the water balance in a papermachine comprises measuring the electrical conductivity of the water entering a press means entrained in one or more press felts, separately measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and comparing the measured

-5-

electrical conductivities to determine the material balance.

The invention also provides apparatus for monitoring the water balance in a papermachine comprising first measuring means for measuring the electrical conductivity of the water entering a press means entrained in one or more press felts, second measuring means for measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and means for comparing the measured electrical conductivities to determine the material balance.

The press means may comprise the entire press section of a papermachine, composed of a series of roller nips, or may comprise a discrete roller nip, where each nip in a press section is for example treated as a separate press means for the purposes of determining the material balance.

The measuring means may each comprise an electrohydrodynamic induction flow meter, as disclosed in US 3,528,287.

If a measurement is made of a specific ion concentration such as Cl^+ or SO_3^{++} in each of the input and output streams, a material balance could be determined. Specific ion electrodes have problems with cost, maintenance and excessive specificity. The present invention uses the linear relationship between the concentration of typical papermachine ions and the resulting electrical conductivity and substitutes conductivity for a

-6-

specific ion concentration. Conductivity measures the total of all ions which will provide a more consistent measurement. Conductivity measurement is simple and requires unsophisticated instrumentation and little day-to-day maintenance.

5 An embodiment of apparatus according to the invention is illustrated by way of example in the accompanying drawing, which is a diagram illustrating the apparatus.

10 A press section 10 of a papermachine comprises a plurality of nips provided by upper presser rolls 11 and lower anvil rolls 12. A fibrous paper or tissue web 13 enters the section 10 from the right side of the drawing, and leaves towards the left, after passing through the series of nips.

 The web 13 is passed through the press section 10 between an upper press felt 14 and a lower press felt 15, which are cleaned by conditioning sprays 17, 18.

15 Excess moisture is drawn from the felt/web system following each press nip by a vacuum dewatering device 19, such as a respective Uhle box. At the outlet end of the press section 10, excess water is mechanically discharged, and collected by a collecting trough 20.

20 Means for measuring the electrical conductivity of entrained water are provided in the form of sensors 21, 22 measuring the conductivity of the upper and lower felts respectively at the input end of the press section 10,

-7-

and sensor 23 measuring the conductivity of the paper or tissue web 13 as it leaves the press section.

Signals corresponding to the measured values of conductivity are fed to a processor 24, which in combination with measuring of other factors as set out in the following Example, calculates a material balance.

EXAMPLE

The material balance may be calculated as follows.

Flow gpm x Conductivity IN = Flow x Conductivity OUT

In:

Wet Web + Showers

Wet Web gpm calculated = f(Tons/day, % water - (standard or measured))

Wet Web conductivity measured or calculated from previous press nip

Showers gpm - measured or calculated = f(nozzle size, pressure)

Showers conductivity - measured and weight averaged

Out:

Vacuum dewatering flow and conductivity - measured

Press water flow and conductivity - measured

Wet Web gpm = Wet Web in - Vacuum dewatering out - Press water flow

The unknown is now Wet Web conductivity out and is calculated by solving the equation for conductivity.

WWI gpm x WWI cond + Shower gpm x Shower cond =

Out:

-9-

Wet Web Out = WWO gpm x conductivity - calculated

Vacuum dewatering = gpm x conductivity - measured

Press Out = gpm x conductivity - measured

Shower water flow = gpm leaving press nip (X_p) + gpm leaving vacuum

5 dewatering (X_u)

$X_u = \text{Shower gpm} - X_p$

Net Web flow out = gpm leaving press nip (Y_p) + gpm leaving vacuum
dewatering (Y_u)

$Y_u = \text{Net Web flow out} - Y_p$

10 Uhle box balance

Solids out = Flow x Conductivity

Flow = X_u

Conductivity = C_u

Solids In = Solids from shower water + solids from wet web

15 Solids from shower water = Shower conc. x Shower water leaving at Uhle
box

$= C_s \times S_u$

Solids from wet web = Wet web conductivity x Wet web water leaving at
Uhle box

20 $= WW_c \times WW_u$

$C_u \times X_u = WW_c \times WW_u + S_c \times S_u$

-10-

$$X_u = WW_u + S_u$$

$$WW_u = X_u - S_u$$

$$C_u \times X_u = WW_c \times (X_u - S_u) + S_c \times S_u$$

$$S_u = \frac{C_u \times X_u - WW_c \times X_u}{(S_c - WW_c)}$$

S_u is now the gallons per minute of shower water that is removed in the Uhle box flow. The amount of shower water removed at the press is now the Total Shower flow minus S_u. Since the Uhle box flow is known the amount of wet web water removed at the Uhle box is now calculated as the difference between the total and S_u. The amount of Wet web water removed at the press can be calculated based on the total press flow if known or a similar material balance at the press nip.

Press Cond x Press flow = wet web cond x wet web flow at press +
Shower cond x Shower flow at press

$$C_p \times X_p = WW_c \times WW_p + S_c \times S_p$$

Press flow = Wet Web flow + Shower flow

$$X_p = WW_p + S_p$$

$$C_p \times (WW_p + S_p) = WW_c \times WW_p + S_c \times S_p$$

$$WW_p = \frac{S_c \times S_p - C_p \times S_p}{(C_p - WW_c)}$$

The total flow at the press can now be calculated:

$$X_p = WW_p + S_p$$

-11-

The material balance (conductivity x flow) enables one to calculate the overall flow in and out of each nip. Comparing the measured versus the calculated flows allow the calculation of a flow error that is then applied to the outgoing sheet to accurately determine sheet consistency. This error is applied to the shower flow but could be applied to the measured weir flows but the resulting sheet consistency would be the same.

The measurement of sufficient flows and conductivities in a press section allows a material balance to be performed that will calculate the exiting % solids leaving each press nip. In addition the distribution between the press nip and press fabric dewatering device of water leaving the wet web can be determined. Finally the distribution of shower water applied to the press fabric between the nip and the dewatering device can be determined.

By measuring these flows and conductivities continuously an on-line water balance can be used to optimise the performance of the press section and its components.

-12-

CLAIMS

1. A method of monitoring the water balance in a papermachine comprising measuring the electrical conductivity of the water entrained in one or more press felts on entry to a press means,
5 separately measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and comparing the measured electrical conductivities to determine the material balance.

2. A method according to claim 1 wherein the electrical conductivities
10 are each measured by measuring the concentration of the same specific ions at entry to and on leaving the press means, and the linear relationship between the concentration if said ions are used to determine the electrical conductivity.

3. A method according to claim wherein the material balance is
15 calculated using the following formula:-

$$\text{Flow (gpm)} \times \text{Conductivity IN} = \text{Flow (gpm)} \times \text{Conductivity OUT}$$

4. A method according to claim 3 wherein the IN side of the equation is calculated using the following data:-

1) Weight of Wet Web, as gpm = f(Tons/day % water)

20 2) Wet Web conductivity measured or calculated from previous press nip

-13-

- 3) Showers, as gpm, = f(nozzle size, pressure)
- 4) Showers conductivity - measured and weight averaged, where
f = flow rate, in gpm, as water.

5. A method according to claim 3 or 4 wherein the OUT side of the equation is calculated using the following data:-

- 1) Vacuum dewatering flow and conductivity, as measured;
- 2) Press water flow and conductivity, as measured;
- 3) Wet Web gpm, as Wet Web in minus vacuum dewatering out, minus press water flow.

6. A method according to claim 5 wherein wet web conductivity at the outlet is calculated by solving the equation:-

$$\text{WWI gpm} \times \text{WWI cond} + \text{Shower gpm} \times \text{Shower cond} =$$

$$\text{Uhle gpm} \times \text{Uhle cond} + \text{Press gpm} \times \text{Press cond} + (\text{WWI gpm} - \text{Uhle gpm} - \text{Press gpm}) \times \text{WWO cond},$$

$$\text{wherein WWO cond} = \frac{A + B - C - D}{E}, \text{ wherein}$$

$$A = \text{WWI gpm} \times \text{WWI cond}$$

$$B = \text{Shower gpm} \times \text{Shower cond}$$

$$C = \text{Uhle gpm} \times \text{Uhle cond}$$

$$D = \text{Press gpm} \times \text{Press cond}$$

$$E = \text{WWI gpm} - \text{Uhle gpm} - \text{Press gpm}$$

-14-

7. A method according to claim 1 wherein the solids balance is determined from the following data:-

In

Wet Web in = WWI gpm x conductivity

5 Shower in = Shower gpm x conductivity, as measured

Out

Wet Web Out = WWO gpm x conductivity, as calculated;

Vacuum dewatering = gpm x conductivity, as measured;

Press Out = gpm x conductivity (as measured);

10 Shower water flow = gpm leaving press nip (Xp) + gpm leaving vacuum dewatering (Xu), wherein

Xu = Shower gpm - Xp, and

Net Web flow out = gpm leaving press nip (Yp) + gpm leaving vacuum dewatering (Yu), and

15 Yu = Net Web outflow - Yp.

8. A method according to claim 7 wherein the Uhle box balance is determined from the following data:-

Solids out = Flow x Conductivity

Flow = Xu

20 Conductivity = Cu

Solids In = Solids from shower water + solids from wet web

-15-

Solids from shower water = Shower concentration (Cs) x Shower water leaving at Uhle box (Su)

Solids from wet web = Wet web conductivity (WWc) x Wet web water (WWu) leaving at Uhle box

5 so that $C_u \times X_u = WWc \times WWu + C_s \times S_u$.

9. A method according to claim 8 wherein S_u = the flow rate of shower water in gallons per minute of shower water removed by the Uhle box flow, the amount of shower water removed at the press is determined as Total shower flow minus S_u , and the amount of Wet Web water removed at the press is calculated by:-

Press Cond x Press flow = Wet Web cond x Wet Web flow at press,
+ Shower cond x Shower flow at press,

i.e. $C_p \times X_p = WWc \times WWp + S_c \times S_p$,

wherein Press flow (X_p) = Wet Web flow (WWp) + Shower flow (S_p),

so that

$C_p \times (WWp + S_p) = WWc \times WWp + S_c \times S_p$, and

$WWp = \frac{S_c \times S_p - C_p \times S_p}{C_p - WWc}$,

20 and the total flow at the press is determined by $X_p = WWp + S_p$.

10. A method according to claim 9 wherein the overall flow in and out of

-16-

each nip is calculated and the measured versus calculated flows compared to allow calculation of a flow error which is then applied to the outgoing sheet to determine sheet consistency.

- 5 11. Apparatus for monitoring the water balance in a papermachine comprising first measuring means for measuring the electrical conductivity of water entering a press means entrained in one or more press felts, second measuring means for measuring the electrical conductivity of the water entrained in the paper web on leaving the press means, and means for comparing the measured
- 10 electrical conductivity to determine the material balance.
12. Apparatus according to claim 11 further comprising apparatus for measuring and reporting flow rates of water applied to the felt before the press means, and of water collected from the felt and paper web in the press means.
- 15 13. Apparatus according to claim 11 or 12 including calculator means adapted to receive said measurements of electrical conductivity and flow rate and to calculate the material balance according to a method as set out in any one of claims 1 to 10.
14. Apparatus according to any of claims 11 to 13 wherein the press
- 20 means comprise the entire press section of a papermachine, said section comprising a plurality of serially arranged roller nips.

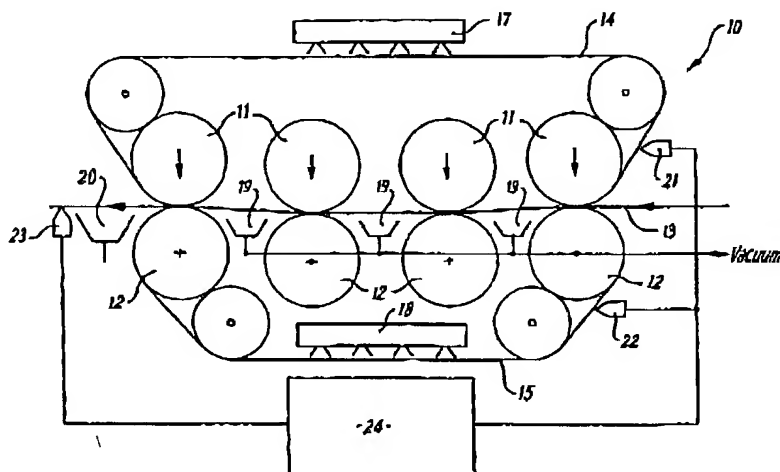
19. Apparatus according to claim 18 wherein a further such sensing means is located adjacent a paper web immediately after its emergence from said press section.

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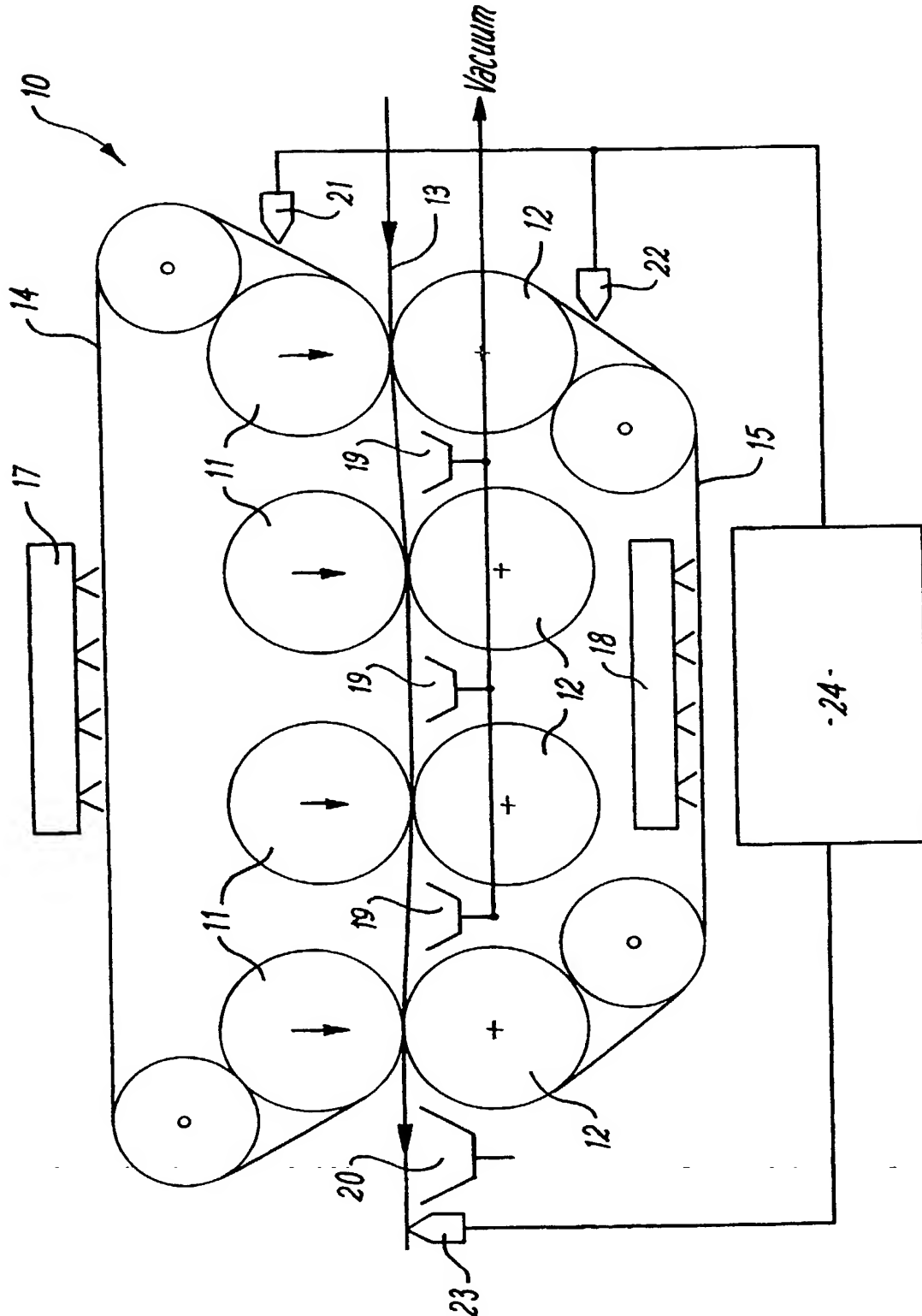
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(54) Title: METHOD AND APPARATUS FOR MONITORING WATER BALANCE IN A PAPERMACHINE



(57) Abstract

A press section of a papermachine has upper and lower press felts (14, 15). Electrical conductivity sensors (21, 22) measure the electrical conductivity of the felts before entry to a press section. A further electrical conductivity sensor (23) senses the electrical conductivity of a paper web (13) as it emerges from the press section. Measurements are also taken of the flow of cleaning showers (17, 18) applied to the felts, and of water removed by the dewatering devices (19) in the press section, and appropriate signals corresponding to these values are applied to a processor (24), which determines a material balance in accordance with a procedure set out in the description.



DECLARATION FOR PATENT APPLICATION

Docket Number (optional) W1100/20054

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD AND APPARATUS FOR MONITORING WATER BALANCE IN A PAPER MACHINE

the specification of which is attached hereto unless the following box is checked:

xx Was filed on August 4, 1999 as United States Application Number or PCT International Application
Number PCT/GB99/02328 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56. I hereby claim foreign priority benefits under 35 U. S. C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Claimed

(Number)

(Country)

(Day/Month/Year Filed)

Yes No

(Number)

(Country)

(Day/Month/Year Filed)

Yes No

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below:

60/095,563
Application Number06 August 1998
(Filing Date)

Application Number

(Filing Date)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international date of this application.

PCT/GB99/0232804 August 1999Pending

(Application Number)

(Filing Date)

(Status-patented, pending, abandoned)

(Application Number)

(Filing Date)

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I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Alan H. Bernstein (Registration No. 19,315); Stanley H. Cohen (Registration No. 20,235); Manny D. Pokotilow (Registration No. 22,492); Barry A. Stein (Registration No. 25,257); Martin L. Faigus (Registration No. 24,364); Eric S. Marzluf (Registration No. 27,454); Robert S. Silver (Registration No. 35,681); Scott M. Slomowitz (Registration No. 39,032); Michael J. Berkowitz (Registration No. 39,607); David M. Tener (Registration No. 37,054); James J. Kozuch (Registration No. 39,733); Frank M. Linguitti (Registration No. 32,424); Gary A. Greene (Registration No. 38,897); Marilou E. Watson (Registration No. 42,213); Michael J. Cornelison (Registration No. 40,395) and Christopher Marrone (Registration No. 46,101), care of Caesar, Rivise, Bernstein, Cohen & Pokotilow, Ltd., 12th Floor, Seven Penn Center, 1635 Market Street, Philadelphia, Pennsylvania 19103-2212, my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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Full name of sole or first inventor (given name, family name) DAVID ANDREW LILBURNInventor's signature David Andrew LilburnDate 4/24/2001Residence Pittsboro, North CarolinaCitizenship U.S.A.Post Office Address 382 Redbud, Pittsboro, North Carolina 27312

Full name of second joint inventor, if any (given name, family name) _____

Second Inventor's signature _____

Date _____

Residence _____

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Additional inventors are being named on separately numbered sheets attached hereto.